Noteworthy anatomical and physiological researches.

Anatomy of Vellozieae.[1]

The *Vellozieae*, a tribe of *Amaryllidaceae*, are known from South America and Africa, but have their largest distribution in Brazil. Only two genera, *Vellozia* and *Barbacenia*, constitute the tribe, and these are all perennial, with erect stems, branching dichotomously. The leaves are long, erect and linear, more or less carinate, are provided with large sheaths, and form fascicles at the upper part of the branches. The height of certain species averages two meters. The most characteristic feature, however, is the thick coating of roots in *Vellozia*, which develop from the stem and proceed within the leaf-sheaths towards the ground. The roots are thus only visible at the base of the trunk, when the old sheaths have faded away.

A transverse section of the trunk of *Vellozia* is round and shows a few relatively thin and triangular branches, surrounded by a huge mass of roots. The anatomical structure of these roots is identical with that of a normal monocotyledonous root, but the vessels are often filled with a brown or yellow substance, probably a kind of resin, especially abundant in *Vellozia*. The central part of the root is occupied by a heavy layer of exceedingly thick walled stereome. The endodermis is thin walled, sometimes starch bearing. The inner bark has an open, loose structure, and is surrounded by the outer bark, which is here composed of a cylindric layer of stereomatic tissue.

Outside these tissues is a hypoderm of a single stratum of thin-walled cells and finally the epidermis, which sometimes develops root-hairs. The hypoderm is stained blue by iodine and sulphuric acid.

The peculiar feature of the roots extending along the stem within the leaf-sheaths seems to be common in the genus *Vellozia*, but is as yet unknown in *Barbacenia*. The function of this fibrous coat of roots seems to be to gather moisture from fogs and rains. This explanation is the more evidently correct when we consider the localities in which the

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[1] WARMING, Eug. Note sur la biologie et l'anatomie de la feuille des Vellosiacées. (Extrait du Bull. l'Acad. roy. d. Sc. Copenhague 1893).

plants grow. They are largely inhabitants of stony, sunny places with but little earth for the penetration of their roots. They are, therefore, protected against excessive drought by a fibrous coating, consisting not only of the roots but also of the remaining fibers of the leaf-sheaths. The author has observed that this fibrous coat absorbs water very rapidly and in large quantities. It is also probable that the erect and more or less carinate leaves serve the same purpose, viz., for a centripetal absorption of water. The stem is thus protected against excessive evaporation rather than against the frequent fires of the campos.

The structure of the leaf shows several peculiarities. The author has studied this especially from sections of the median portion of the blade, since it was observed that there exist certain differences between the structure of the basal and the median portion of the same blade. *Vellozia compacta*, for instance, shows at the leaf-base a tissue which reminds one very much of the thin-walled, transparent tissue so characteristic of Gramineæ, Cyperaceæ, Juncaceæ, etc., while this tissue was not observed higher up on the same leaf.

The subepidermal tissue of the blade shows above the carene a development corresponding to the bulliform cells described by Duval Jouve for several monocotyledonous families. These cells have undoubtedly the same mechanical function in the Vellozieæ as in those families, serving for involution of the blade in a dry atmosphere. The stomata are arranged in longitudinal rows. *Vellozia* has a distinct palisade-tissue, which is almost lacking in *Barbacenia*, and the structure thus becomes nearly isolateral. In the genus *Barbacenia* certain cells of the mesophyll were observed to contain water. Similar water-storing cells were also observed in *Vellozia*, but in this case they belonged to the hypoderm.

There is a certain distinction between the development of the various tissues of the leaf not only within these genera, but also within their species. These differences appear to the author to be of value in the anatomical characterization of the species of the tribe. THEO. HOLM.

Ombrophilous and ombrophobic organs of plants.[1]

Although this treatise on the adaptation of plants to extreme amounts of rain is only preliminary, it nevertheless

[1] J. WIESNER: Ueber ombrophile und ombrophobe Pflanzenorgane. Sitzungsberichte d. kais. Akad. d. Wissensch. Wien. **102**: —. 1893.

contains results of great interest and valuable suggestions for further investigations. It was a problem the author undertook to investigate in the moist climate of Java, but in order to prepare himself for this, he made some experiments in Austria and the results are recorded in the present paper. The relation between leaf-shape and rain-fall in tropical regions, where moisture and heat prevail, has already been studied by Stahl, Jungner and others. But the direct mechanical effect of rain upon the plants and the power of resistance possessed by them against this factor has so far not been taken into consideration.

It is well-known to cultivators that many plants are only able to thrive when they obtain a certain amount of water, and that several species die if they get too much. The full-grown leaves of the potato-plant decay and young leaves on autumnal shoots of certain trees are destroyed, when exposed to excessive rain-fall. We know, however, from amphibious plants, that there is a great difference in regard to the ability of plants to withstand the effects of water. We have, also, learned by water-cultures that the roots of terrestrial plants thrive in water, while the aerial parts of these same plants die when they become submersed. In order to test this varying power of resistance against water, the author made the following experiments:

Shoots cut from various plants were placed upon a sieve and continuously sprinkled with artificial rain day and night, the temperature of the water being between 16 and 20° C. The power of resistance of these plants was shown by this experiment to be very different. The shoots of Solanum tuberosum decayed within a few days, while those of Lysimachia Nummularia and Tradescantia zebrina kept fresh for four weeks, and some hot-house Selaginellæ were healthy even after an exposure to eight weeks steady rain. It was observed during the same experiment that the youngest leaves decayed first and then the oldest, while those which were in their greatest vigor were the last ones to decay. Solanum tuberosum was an exception, the very youngest leaves showing the greatest power of resistance. A similar result was obtained by submersing shoots in basins where a constant current of water was flowing. Shoots of the same plants died much sooner if they were submersed in stagnant water. There was also observed to be a great difference in regard to

the time of decay, when the experiments were made in daylight and in a dark room. The decay set in much earlier in the dark, evidently due to the fact that many bacteria are arrested in their development and propagation when exposed to light.

It appears from these experiments that the best way to form a correct judgment regarding the resistance of plant-organs against the influence of water is to keep them in stagnant water. In these experiments the full-grown leaves were the first to lose their turgescence. They became soft and soon decayed. Fresh shoots of Lysimachia Nummularia were placed in the decayed liquid resulting from this experiment, and they kept fresh for fourteen days. Pieces of marchantia thallus lived about eight days.

Another kind of experiment was made with potted plants. These were exposed to continuous rain, but in such a way that the water was prevented from saturating the earth. A plant of Phaseolus multiflorus, 80^{cm} in height, died entirely after thirty-two days, Tradescantia zebrina after forty-five, while T. guyanensis on the contrary was still healthy after sixty-two days.

The same was the case with Begonia magnifica and various hot-house Selaginellæ. These results show that various plants possess an unequal power of resistance against a continuous rain and the presence of water. The author believes himself justified in distinguishing two categories of plant-organs: the "ombrophilous," or such as love or rather tolerate the rain; the "ombrophobic," which dread the rain. These terms are, of course, only to be applied to organs above ground. The underground roots are evidently always hydrophilous, even in plants which have ombrophobic foliage, as for instance Impatiens noli-tangere.

We might now at the first glance think that these two categories of organs belong to plants which are limited to distinct localities, say to dry or moist places, and that the ombrophilous foliage should characterize the hygrophytes and the ombrophobic the xerophytes. But this conclusion is not a valid one since there are some plants whose foliage is ombrophobic, and yet which can not be considered as xerophytes, as for instance Solanum tuberosum. So too there are hygrophytes which are decidedly ombrophobic, like Impatiens noli-tangere.

Impatiens grows in moist and shaded places and requires a large supply of water for its existence. But the leaves of this plant do not get wet by rain, and it, therefore, obtains the necessary amount of water exclusively through the roots. In contrast to Impatiens is Sanicula Europæa from similar situations. This is decidedly ombrophilous, and the leaves become easily wetted by rain. This fact was also proved by submerging leaves of both plants in stagnant water, where those of Impatiens decayed in three days, and those of Sanicula only after eleven days.

The xerophytes are, according to the author's experience, often ombrophobic in a greater or less degree. It would appear that those with rather dry leaves do not withstand the effects of rain as those with thick succulent leaves, as for instance sempervivum and echeveria. The hygrophytes contain, as already mentioned, representatives with foliage of both categories, although the majority are very likely ombrophilous, but those with ombrophobic foliage are protected not only by the locality (shaded places) but also, and quite especially, by the waxy covering of their foliage.

The aquatics are hydrophilous as are also the underground roots, which are constantly exposed to the influence of water.

Another question arises as to the power of plants to resist the injurious effect of an excess of water, by which they might become thoroughly soaked. We have here to do with a mechanical and chemical power of resistance. The mechanical power may be in the "bloom" that covers the leaves of many plants, and which prevents them from being wetted unless exposed to an excessive rainfall. But those leaves that while easily wetted by rain are still able to preserve their vitality must possess a purely chemical power. The author believes this to consist in the presence of antiseptic substances. He has shown by experiments that ombrophilous shoots of Lysimachia Nummularia, Selaginella spp., begonia, tradescantia, etc., are able to keep fresh for a long time in a decayed liquid. He has, also, observed that the presence of such ombrophilous organs delays the decomposition of ombrophobic organs, when exposed together to a continuous shower of water. It would appear therefore that ombrophobic foliage is protected in a purely mechanical way, while the ombrophilous is protected by the presence of antiseptic substances.

THEO. HOLM.